Digitalization and Economic Growth in Algeria: An Empirical Analysis of ICT's Impact on Economic Performance

الرقمنة والنمو الاقتصادي في الجزائر، دراسة تحليلية لأثر تكنولوجيا المعلومات والاتصالات على الفعالية الاقتصادية

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Abstract:
This study sheds light on the analysis of the impact of information and communication technology (ICT) on the economic growth of Algeria using an ARDL model. The ICT indicators include mobile subscriptions, internet users, and fixed telephone subscriptions, and the economic growth is represented by GDP per capita. The research analyses the short-term and long-term impacts of these ICT variables on GDP per capita, presenting an overview of the dynamic relationship between digitalization and economic growth in Algeria. The findings show a positive relationship between dependent and independent variables and are expected to guide policymakers in designing effective ICT policies to promote sustainable growth and boost Algeria's global competitiveness. However, the study noticed that challenges such as the digital divide, inadequate infrastructure, and regulatory barriers need to be addressed to fully capitalize on the benefits of digitalization in Algeria.
Keywords: digitalization; economic growth ; ICT ; ARDL.
Jel Classification Codes: O32 ،O38.

الملخص:
تهدف هذه الدراسة إلى تحليل أثر مختلف مؤشرات تكنولوجيا المعلومات والاتصالات، مثل الاشتراكات في الهواتف النقالة، ومستخدمي الإنترنت، والاشتراكات في الهواتف الثابتة، على النمو الاقتصادي في الجزائر باستخدام نموذج "(ARDL) ". وتقدم الورقة لمحة عامة عن مفهوم رقمنة التكنولوجيا وعلاقتها بالنمو الاقتصادي، حيث اضطلعت الحكومة الجزائرية بعدة مبادرات لإدماج التكنولوجيات الرقمية في مختلف القطاعات، بما في ذلك الحوكمة الإلكترونية، وبرامج محو الأمية الرقمية. يقدم البحث نظرة عن العلاقة الديناميكية بين التكنولوجيا الرقمية والأداء الاقتصادي في الجزائر. و قد تساعد نتائج الدراسة واضعي السياسات على تصميم سياسات فعالة في مجال تكنولوجيا المعلومات والاتصالات لتعزيز النمو الاقتصادي المستدام وتعزيز القدرة التنافسية العالمية للجزائر.

الكلمات مفتاحية: التكنولوجيا الرقمية، النمو الاقتصادي، تكنولوجيا المعلومات والاتصالات، نماذج ARDL.
تصنيف JEL : O32، O38.

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1. Introduction:

Over the past few decades, digitalization has emerged as a key driver of economic growth, especially in emerging nations such as Algeria. This global movement demonstrates the significant influence of integrating information and communication technologies (ICT) on enhancing economic development. The Algerian government has initiated many programs to introduce digital technology into different sectors, recognizing the transformative potential of digitalization. They are implementing measures such as establishing online government platforms to enhance public services, initiating programs to encourage individuals to use digital platforms to improve service quality, and endeavoring to attract private sector investments to expand technological infrastructure. This is a component of a broader global trend towards increased utilization of digital tools in both daily life and professional settings.

The burgeoning startup ecosystem has significantly contributed to enhancing economic diversity by fostering innovation and encouraging the emergence of new entrepreneurs. Algeria is on the threshold of seeing substantial economic growth as it adopts digitalization, resulting in improved efficiency, reduced transaction costs, and the creation of new market opportunities. However, To effectively exploit the benefits of digital changes, it is crucial to tackle difficulties such as the technology gap between individuals, inadequate infrastructure, and legislative barriers that restrict growth.

This study investigates the impact of several information and communication technology (ICT) factors, such as mobile subscriptions, internet users, and fixed telephone subscriptions, on the economic growth of Algeria using an Autoregressive Distributed Lag (ARDL) model. The research examines both the immediate and long-term effects of these ICT variables on GDP per capita. This provides valuable insights into the mutually beneficial connection between digitalization and the economy. The findings will help policymakers on how to design effective ICT policies that can effectively enhance the economy and increase Algeria's competitiveness.

2. Literature review

In recent years, scientists have developed many definitions to clarify the concept of digitalization. (Brennen & Kreiss, 2016) argue that the focus is on utilising digital means of communication and examining the transformative impact of digital technologies on social lifestyles.

Digitalisation refers to integrating digital technologies into business operations to increase profitability. Digitalisation, seen from different angles, refers to conducting business activities in a digital environment. It creates digital representations of various objects. Digitization transforms many aspects of our communication, interaction, commercial activities, and organisational operations into digital data. This can refer to integrating digital and physical components, such as offering customer support through various channels, coordinating marketing strategies, or utilising a combination of automated machinery, manual labour, and electronic services in the production process. The process of digitalization fundamentally alters how individuals carry out their work tasks.

Human resources professionals use various digital tools (Mircica 2020). These digital systems empower individuals to work in a distinct "digital" way, characterized by standardization, centralization, and the ability to conduct tasks from any place (Ionescu et al., 2021). To transition to a digital environment, it is necessary to alter the prevailing culture. This prioritizes individuals rather than solely focusing on technology. To undertake transformation, firms must prioritize their consumers, with leaders taking the lead and significant changes in mindset and behavior. Furthermore, it refers to using technology that facilitates employee tasks and improves work processes (Popescu et al., 2023). When referring to transforming digital, we are describing the process of converting traditional information into digital data. However, it refers to the transformation of society that occurs when individuals universally use digital technology to create, manage, and exchange information.

Using digital technology enables the development of working environments, online government services, e-commerce websites, social networking platforms, and online information databases.

Explaining the term digitalization is challenging due to its multicomplex aspects. The notion revolves around integrating technology across all aspects of a firm, transforming its functions and the benefits it provides to customers (Androniceanu et al., 2020).

The definition of digitalization can vary for each business. For banks, it refers to the process of digitizing data and making it accessible to customers across online platforms. For sellers, it signifies having an online platform to market and sell goods and services.

Countries consistently attempt to establish effective regulations to foster longevity and economic prosperity (Belás et al., 2021). The objective of digital transformation is to increase economic growth. According to Shpak et al. (2020), adopting digitalization facilitates development and improves sales performance. Economic growth refers to

the expansion of production and provision of goods and services within a country (Kuziyeva et al., 2022).

Many researchers analyse the factors that contribute to economic growth. They examine the impact of managers (Erhan et al. 2022), the effects of regulations (Virglerova et al. 2020), societal shifts (Uslu et al. 2020), or operational procedures (Belas et al. 2020) on growth. Our analysis used Gross Domestic Product (GDP) as the primary measure of growth. Growth is determined by analysing the fluctuations in GDP per capita. There are two types of factors that can contribute to economic growth:

direct and indirect factors. The components of a direct nature include individuals engaged in work, physical resources, and technological tools. Indirect factors encompass expenditures on research, financial management practices, taxation, consumer spending patterns, regulations about the environment, and international trade (Meyer et al., 2017; Meyer & Shera, 2017; Stverkova & Pohludka, 2018).

We conduct a study to examine the influence of these elements on the process of digitization and the subsequent effect on economic growth. Economic growth is a topic widely discussed due to its important impact on the overall performance of society. The combination of digitalization and economic growth leads to a new type of economy known as the digital economy. The digital economy is often viewed as the fourth major change in the industrial sector. The adoption of new technologies and methods has the potential to significantly impact economies, employment, and society as a whole (Fil'a et al., 2020; Ślusarczyk & Haque, n.d.; Shpak et al., 2020). The digitization of economies will enhance accessibility to education, employment opportunities, and financial services. However, in the immediate term, this could reduce monotonous and less productive employment opportunities across several sectors of the economy, such as manufacturing, agriculture, and services (Androniceanu et al., 2020).

According to Belloumi & Touati (2022), developing countries can expedite their progress and reduce the gap with affluent nations by making substantial investments in ICT infrastructure. The authors explain the transformative impact of enhanced information and communication technology (ICT) on the global economy, the determinants of a country's competitive advantage, and strategies for improving societal well-being. However, it is important to note that whereas small-scale studies have indicated that investment in information technology (IT) increases productivity, the overall data regarding how information and communication technology (ICT) impacts productivity and economic

growth has been more inconclusive. Our study examined the impact of digitalization on economic growth. We examined the key factors that influence the economic growth of digitalization and the process of countries' development. We accomplished this by examining some key factors. The structure of our study has distinct sections that outline our research methodology, present our findings, and offer our analysis and interpretation of the results.

3. Methodology

3.1. Data and Sample:

The study employs data from Algerian country covering the period 1990-2022. The variables included are economic growth (GDP per capita), and ICT including various indicators such as fixed telephone subscriptions per 100 people, mobile cellular subscriptions per 100 people, and internet users per 100 people(*World Bank Open Data*, n.d.). These variables were defined by the World Bank as follows:

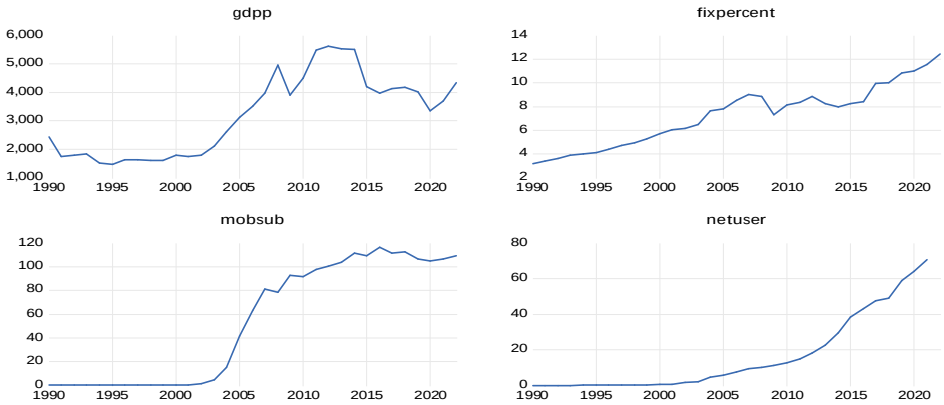
Netuser: (Individuals using the Internet (% of the population) that means the Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV, etc.

Fixsub: Fixed telephone subscriptions refer to the sum of the active number of analog fixed telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents, and fixed public payphones.

Mobsub: Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging, and telemetry services.

From the statistics provided by the World Bank we can Graph these time series as follows:

Figure 1: Graphs of variables of the study



Source: Eviews software outputs

The graphs provide us an overview of the evolution of economic growth measured as GDP per capita and various ICT indicators in Algeria through the period 1990 to 2022. The **GDP per capita** shows a fluctuating trend over the years, reflecting the economic challenges and growth phases the country has experienced. The growth which is the GDP per capita indicates an increasing trend due to economic development, the rise of oil prices political change, and digitalization. The using of the internet began in 1994 in Algeria and shows a steady increase illustrating an expanding adoption of digitalization and greater availability of internet access among individuals. The upward trend in the internet usage is correlated to the global shift towards digital evolution, pointing out the need for improved ICT infrastructure availability. Fixed telephone subscriptions reflect a stable trend with a small change indicating a relatively constant level of conventional telecommunication infrastructure technology. The steady and continued use of fixed-line telephony has not seen the same level of rapid expansion as mobile technology. Mobile cellular subscriptions illustrated an upward trend starting from the late 1990s. This rise reflects the rapid adoption of mobile technology, which has become the main means of communication for most Algerians.

In general, the data indicate that as Algeria has increasingly adopted digital technology there has been a significant growth in mobile and internet usage, contributing to a positive impact on economic growth.

Nevertheless, the fluctuation in GDP per capita also indicates that ICT development is essential for several economic factors.

3.2. Model specification: The study employs an autoregressive distributed lag (ARDL) approach to examine the short and long-run relationships between the variables.

4. Results:

In the first step, we have to perform a unit root test to get an overview of the stationarity of the time series.

4.1. Unit root test:

From the output of the EVIEWS program we the following tables:

Table1: Unit root Test (PP)

At level (t-stat prob)				
	GDPP	FIXTEL	MOBSUB	NETUSER
With Constant	***0.772***	***0.973***	***0.864***	***0.999***
With Constant & Trend	***0.6015***	***0.616***	***0.730***	***0.999***
Without Constant & Trend	***0.750***	***0.999***	***0.849***	***0.999***
At the first difference				
With Constant	***0.000***	***5.413***	***0.0187***	***0.318***
With Constant & Trend	***0.001***	***0.000***	***0.0491***	***0.003***
Without Constant & Trend	***1.011***	***6.255***	***0.006***	***0.323***

Source: Eviews software output

Table2: Unit root Test (ADF)

At level (t-stat prob)				
	GDPP	FIXTEL	MOBSUB	NETUSER
With Constant	***0.781***	***0.963***	***0.673***	***0.999***
With Constant & Trend	***0.702***	***0.644***	***0.206***	***0.999***
Without Constant & Trend	***0.755***	***0.998***	***0.616***	***0.999***
At the first difference				
With Constant	***0.000***	***0.005***	***0.136***	***0.999***
With Constant & Trend	***0.001***	***0.000***	***0.0491***	***0.003***
Without Constant & Trend	***0.009***	***0.007***	***0.100***	***0.999***

Source: Eviews software output

The results of the unit root test, specifically the Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) tests, can be interpreted as follows:

4.1.1.Phillips-Perron (PP) Test

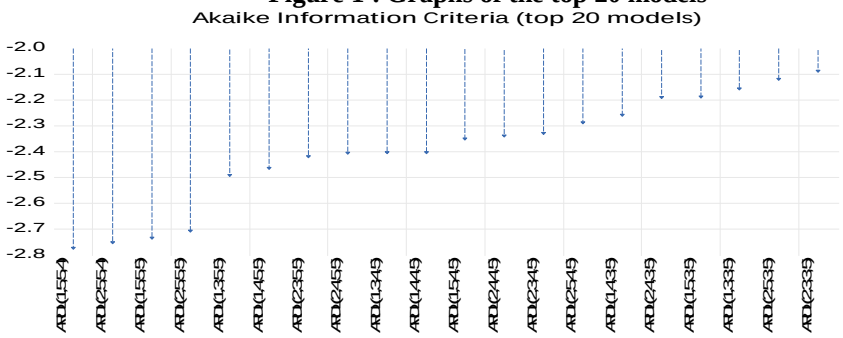
When analyzing the data, the t-statistics for GDPP, FIXTEL, MOBSUB, and NETUSER, whether with constant, constant and trend, or without either are all not statistically significant at the 1%, 5%, and 10% significance levels. The p-values exceed the significance thresholds, showing that the null hypothesis of a unit root cannot be rejected, thereby concluding that these variables are non-stationary at their levels. However, both GDPP and FIXTEL exhibit significant t-statistics at the 1% after the first difference, in all specifications, which means they are stationarity.
The t-statistics of MOBSUB and NETUSER are statistically non-significant at the level for all specifications. However, when they are differenced once, they indicate that they are stationary when taking into account only the constant and trend at the 5% level.

As a result, all variables (GDPP, FIXTEL, MOBSUB, NETUSER) are non-stationary at the level. However, GDPP and FIXTEL become stationary at first difference. MOBSUB indicates stationarity in the PP test but not in the ADF test. NETUSER is stationary in both tests with a constant and trend, but non-stationary otherwise. Based on this analysis, it is shown that the majority of variables exhibit stationarity after undergoing differencing. Nevertheless, there are certain variables where the PP and ADF tests show some differences.

4.2.Model selection summary

The Eviews software generates a graph, which is displayed as the following output:

Figure 1 : Graphs of the top 20 models



Source: Eviews software output

The ARDL(1,5,5,4) model demonstrates a dynamic and complex relationship between economic growth and ICT indicators in Algeria. By incorporating multiple lags, the model measures the delayed and extended effects of changes in Internet usage, fixed telephone subscriptions, and

mobile subscriptions on GDP per capita. This comprehensive approach offers insights for both economic analysis and policy development. This insight can be used by Policymakers to design ICT policies that account for both immediate and future economic impacts. For example, investments in ICT infrastructure today may yield significant economic benefits in the future.

4.3.The Model:

LOG(GDPP) = 0.896*LOG(GDPP(-1)) + 0.011*MOBSUB - 0.016*MOBSUB(-1) - 0.0053*MOBSUB(-2) + 0.034*MOBSUB(-3) - 0.044*MOBSUB(-4) + 0.0323*MOBSUB(-5) - 0.104*NETUSER + 0.103*NETUSER(-1) + 0.033*NETUSER(-2) - 0.1869*NETUSER(-3) + 0.275*NETUSER(-4) - 0.1614*NETUSER(-5) + 0.192*FIXTEL - 0.0225*FIXTEL(-1) - 0.256*FIXTEL(-2) + 0.544*FIXTEL(-3) - 0.407*FIXTEL(-4) + 0.419

Interpreting the ARDL model results where the dependent variable is the logarithm of GDP per capita in current dollars (LOG(GDPP)) and the independent variables are mobile cellular telephone subscriptions (MOBSUB), internet users (NETUSER), and fixed telephone subscriptions (FIXTEL), we can summarize the results as follows:

4.3.1. Coefficient Interpretation

The coefficient for LOG(GDPP(-1)) is 0.897, indicating that a 1% increase in GDP per capita in the previous period results in an approximate 0.897% rise in the current period, assuming other factors remain inchanged. This coefficient is significant at the 5% level with a p-value of 0.0556. For mobile subscriptions (MOBSUB), the effect is immediate , positive, (0.0114) and significant at the 5% level,

however the lagged values show mixed signs, indicating complex dynamics. Specifically, MOBSUB(-1) and MOBSUB(-5) have negative effects on LOG(GDPP), suggesting that past increases in mobile subscriptions might reduce GDP per capita in the short run, whereas MOBSUB(-3) has a positive effect, indicating a delayed positive impact.

Overall, these patterns reflect the dynamic nature of technology adoption and economic performance. The immediate effect of internet users (NETUSER) is negative (-0.104) and significant, indicating that an initial increase in internet users decreases GDP per capita. However, several lagged coefficients are positive and significant, showing eventual positive impacts: NETUSER(-1), NETUSER(-2), and NETUSER(-4). Meanwhile, NETUSER(-3) and NETUSER(-5) exhibit negative effects, reflecting a mix of short-term negative and delayed positive impacts, likely due to adjustment periods. Fixed telephone subscriptions (FIXTEL) show

an immediate positive and significant effect (0.193), with significant lags indicating transitional effects: FIXTEL(-2) and FIXTEL(-4) have negative impacts, while FIXTEL(-3) shows a positive and highly significant effect, suggesting a strong delayed positive impact. The mixed signs reflect the transitional effects as economies shift from older to newer technologies. Lastly, the constant term (C) is not statistically significant, indicating it does not add much explanatory power on its own in the presence of other variables.

However, the lagged values exhibit a complex image, the variables MOBSUB(-1) and MOBSUB(-5) have negative effects on LOG(GDPP), suggesting that previous increases in mobile subscriptions may reduce GDP per capita in the short run, while MOBSUB(-3) indicates a positive impact, indicating a lagged positive impact. These patterns underscore the dynamic nature of technology adoption and economic performance.

For internet users (NETUSER), the immediate effect is negative (-0.104) and significant, indicating that an initial rise in internet users decreases GDP per capita. Nonetheless, several lagged coefficients turn positive and significant, revealing eventual positive impacts: NETUSER(-1), NETUSER(-2), and NETUSER(-4). Meanwhile, NETUSER(-3) and NETUSER(-5) exhibit negative effects, reflecting a mix of short-term negative and delayed positive impacts, possibly resulting to adjustment periods.

Fixed telephone subscriptions (FIXTEL) variable indicates an immediate positive and significant effect (0.193), with significant lags indicating changing effects: FIXTEL(-2) and FIXTEL(-4) have negative impacts, whereas FIXTEL(-3) shows a positive and highly significant impact, implying a strong delayed positive effect. The mixed signs reflect the transitional effects as economies shift from older to newer technologies. furthermore, the constant term (C) is not statistically significant, indicating it has a limit explanatory value when considered with other variables.

4.3.2. Diagnostic Statistics

The R-squared value indicates that the model explains 99.57% of the variance in LOG(GDPP), while the adjusted R-squared, which accounts for the number of predictors, also explains 98.60% of the

variance. The Durbin-Watson statistic is 2.1204, which is close to 2. This means that there is no significant autocorrelation present in the residuals. The interpretive summary emphasizes that the immediate and delayed impacts of mobile subscriptions (MOBSUB), internet users (NETUSER), and fixed telephone subscriptions (FIXTEL) on GDP per capita are varied, indicating complex short-term and long-term connections. Multiple lags exhibit significance, highlighting the crucial role of previous values of these variables in forecasting the current GDP per capita.

The model demonstrates a remarkable match to the data, accounting for almost all of the variation in GDP per capita. To summarise, the ARDL model demonstrates that mobile subscriptions, internet users, and fixed telephone subscriptions have complex and dynamic effects on GDP per capita. The significant lagged effects indicate that these variables impact economic performance throughout different periods, reflecting the changing nature of technology adoption and its economic consequences.

4.4. Testing the long-run relationship (Bounds test)

Null hypothesis: No levels of relationship.

Tabel3 : Bonds test

Test Statistic	Value	
F-statistic	9.906	
t-statistic	-0.257	
bonds critical values at 5%		
F-Statistic		
	I(0)	I(1)
30	3.71	5.018
Asymptotic	3.23	4.35
t-Statistic		
Asymptotic	-2.86	-3.78

Source : Eviews software output

The analysis of the results can be summarized as follows:

The calculated F-statistic of 9.906 is compared to the critical values at the 5% significance level, which are [3.710, 5.018]. Since 9.906 is more than the upper bound critical values(7.063) at the 1% significance level, we can conclude that we reject the null hypothesis of no cointegration. This indicates a long-term equilibrium relationship among LOG(GDPP), MOBSUB, NETUSER, and FIXTEL. The calculated t-statistic of -0.258 does not fall within the critical bounds for significance at the 5% level, which is [-2.86, -3.78]. thus, the t-statistic does not present evidence contradicting the null hypothesis of no cointegration. However, as the F-

statistic is the primary test in bounds testing and strongly indicates cointegration, the overall conclusion supports the presence of a long-term relationship.

Interpretation of Cointegration Results

The cointegration equation is given by:

CE=LOG(GDPP(-1))−(0.122094·MOBSUB(-1)−0.388140·NETUSER(-1)+0.488·FIXTEL(-1))

This equation represents the long-term relationship between the dependent variable (LOG(GDPP)) and the independent variables (MOBSUB, NETUSER, FIXTEL) at their lagged values. The coefficients in the cointegration equation indicate the long-term impact of the independent variables on the dependent variable. Specifically:

MOBSUB(-1): A one-unit increase in mobile subscriptions is associated with a 0.122 increase in LOG(GDPP) in the long run, holding other variables constant.

NETUSER(-1): A one-unit increase in internet users is associated with a 0.388 decrease in LOG(GDPP) in the long run, holding other variables constant.

FIXTEL(-1): A one-unit increase in fixed telephone subscriptions is associated with a 0.488 increase in LOG(GDPP) in the long run, holding other variables constant.

The bounds test shows a long-term equilibrium relationship between the variables as a group, despite the fact that the individual coefficients are not statistically significant.

The coefficients indicate how each independent variable influences GDP per capita (in logs) in the long run. Although none of these variables are statistically significant, Mobile subscriptions and fixed telephone subscriptions have a positive long-term impact, while internet users have a negative long-term impact. Policymakers should consider the combined effect of technology adoption (mobile, internet, and fixed telephony) on economic performance, as these variables collectively influence GDP per capita over the long term. The absence of individual statistical significance might be attributable to sample size, model specification, or underlying data characteristics. Additional insights may be obtained by further investigation, such as exploring additional data or refinement of the model.

4.5. Residual diagnostics

4.5.1. Normality test

Null hypothesis: Residuals are normally distributed.

A normality test for residuals (such as the Jarque-Bera test) evaluates whether the residuals of the model are normally distributed. However, A high p-value=0.567 (greater than 0.05) indicates that the residuals are likely normally distributed.

4.5.2. Serial correlation LM test

Null hypothesis: No serial correlation

Table 4 : Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.166	Prob. F(2,6)	0.850
Obs*R-squared	1.418	Prob. Chi-Square(2)	0.492019

Source : Eviews software output

The probabilities for F(2,6) and Chi-Square(2) tests are 0.8506 and 0.4921, respectively, both are greater than 0.05. Therefore, we are unable to reject the null hypothesis, revealing no evidence of serial correlation in the residuals up to 2 lags. The absence of autocorrelation in the residuals of the model is a positive sign of model adequacy.

4.5.3. Heteroskedasticity Test

Null hypothesis: Homoskedasticity

Table 5 : Heteroskedasticity Test: Breusch-Pagan-Godfrey

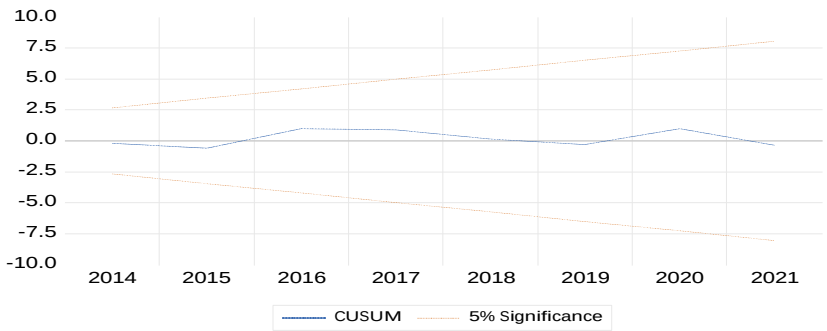
F-statistic	0.1893	Prob. F(18,8)	0.998
Obs*R-squared	8.063	Prob. Chi-Square(18)	0.977
Scaled explained SS	0.6982	Prob. Chi-Square(18)	0.999

Source : Eviews software output

The probabilities for the F(18,8) and Chi-Square(18) tests are 0.9984 and 0.9777, respectively, both of these probabilities are greater than 0.05. Therefore, we fail to reject the null hypothesis, this implies that there is no evidence of heteroskedasticity. This means the residuals have constant variance, which is another favorable indication of model adequacy.

4.5.4. Stability coefficients test

Figure2: CUSUM stability test



Source: Eviews software outputs

The results from the CUSUM stability test assess whether the coefficients in the ARDL model remain stable over the entire sample period. The

graphical representation of this test demonstrates that the test statistic remains within the critical bounds, indicating that the model's coefficients are stable across time, without any structural breaks or changes in the relationship between variables.

Overall Conclusion, for the serial Correlation test, the residuals do not exhibit any serial correlation, suggesting that the model adequately captures the temporal dependencies in the data. Also, regarding the test of heteroskedasticity, there is no evidence of heteroskedasticity, indicating that the residuals have constant variance. Furthermore, the normality test results confirm that the residuals are normally distributed, as indicated by the p-value. These diagnostics collectively indicate that the ARDL model is well-specified and reliable for making inferences and forecasting, as the residuals conform to standard econometric criteria.

5. Discussion:

The ARDL(1,5,5,4) model investigates the correlation between GDP per capita (LOG(GDPP)) and three ICT indicators which are mobile subscriptions (MOBSUB), internet users (NETUSER), and fixed telephone subscriptions (FIXTEL) in Algeria. The model captures both immediate and lagged effects, illustrating the dynamic character of these connections. The coefficient of the lagged dependent variable (0.896) indicates a strong persistence in GDP per capita, suggesting that previous economic performance has a substantial influence on current conditions. The immediate impact of mobile subscriptions on GDP per capita is both positive and significant, indicating a direct boost of economic growth.

Nevertheless, the lagged effects of mobile subscriptions exhibit a combination of positive and negative effects, suggesting that the impact of mobile technology adoption on the economy is subject to short-term complexities. The immediate impact of internet users is negative and significant, possibly as a result of the costs associated with initial adoption. However, many lagged coefficients are positive, emphasizing the long-term advantages of raised internet utilization. The presence of fixed telephone connections has an immediate beneficial impact on GDP per capita, with a combination of lagged effects reflecting transitional dynamics as the economy shifts from older to newer technologies.

The model's diagnostic statistics are robust, with an R-squared of 99.57% and an adjusted R-squared of 98.60%, indicating an excellent fit and high

explanatory power. The Durbin-Watson statistic of 2.1204 suggests no significant autocorrelation in the residuals.
The diagnostic statistics of the model are robust, with an R-squared value of 99.57% and an adjusted R-squared value of 98.60%, indicating a very accurate fit and significant explanatory capability. The Durbin-Watson statistic, with a value of 2.1204, indicates no significant autocorrelation in the residuals. The bound test reveals a long-term equilibrium relationship among the logarithm of GDP per capita (LOG(GDPP)), mobile subscriptions (MOBSUB), internet users (NETUSER), and fixed telephone lines (FIXTEL), which is confirmed by a significant F-statistic. Although the individual coefficients in the cointegration equation do not show statistical significance, the overall model supports the existence of a long-term relationship, indicating that these ICT indicators collectively affect economic performance. Policymakers should take into account the cumulative impact of mobile, internet, and fixed telephony technologies on economic growth, recognizing the complex and changing influence of ICT adoption on the economy.

6. Conclusion and Policy Implications

The study investigated the correlation between digitalization and economic development in Algeria. Focusing on ITC indicators such as mobile subscriptions (MOBSUB), internet users (NETUSER), and fixed telephone subscriptions (FIXTEL). The ARDL(1,5,5,4) model was employed for analysis. This model demonstrates both short-term and lagged impacts, illustrating the dynamic and complex nature of these relationships. The model exhibits a high level of reliability, as evidenced by its R-squared value of 99.57% and robust diagnostic statistics. Furthermore, the bound test provides support for the existence of a long-term equilibrium relationship among the variables.

6.1. Key Findings:

The findings that comprise this study are listed as follows:
Persistence of GDP: The lagged dependent variable coefficient indicates a strong persistence in GDP per capita, suggesting that the previous economic performance significantly impacts current conditions.
Impact of mobile subscriptions: There is an immediate positive and significant effect, indicating that an increase in mobile subscriptions directly boosts GDP per capita, however, the lagged effects are mixed, with both positive and negative impacts, illustrating the complexities of mobile technology adoption and its economic effects over the long run.
Impact of Internet Users: The immediate effect is Negative and significant, possibly as a result of the to initial adoption costs. Nevertheless, the lagged

effects have a Positive and significant after some lagged, highlighting the long-term benefits of increased internet utilization.

Impact of Fixed Telephone Subscriptions: There is an immediate Positive effect and significant, reflecting an initial increase in GDP per capita. And a lagged mixed effects, with some lags showing negative impacts and others positive, which reflects the transitional dynamics from older to newer technologies.

6.2. Policy Implications

- Develop a comprehensive information and communication technology (ICT) strategy that takes into account both short-term and long-term economic effects, in order to capitalize on their significant long-term advantages, and prioritize investments in mobile and internet infrastructure.
- Ensure a harmonious adoption of new technologies with existing ones. Facilitate the smooth transition to digitalization and reduce its short-term adverse effects.
-Deploy programs to reduce upfront costs and obstacles to internet access, such as training programs, financial support, and infrastructure investments to enhance digital accessibility.
-Ensure that effective management of the dynamic process of technology adoption and positive economic implications.
- Regularly monitoring and evaluating the ICT policies and their economic effects to adjust strategies as needed.

Algeria has the opportunity to leverage ICT advancements by implementing these policies, to promote sustainable economic growth and enhance economic performance, ensuring long-term prosperity and competitiveness in the global economy.

7. Annexes:

Annexe1 :

UNIT ROOT TEST TABLE (PP)

	At Level				
		GDPP	FIXTEL	MOBSUB	NETUSER
With Constant	t-Statistic	-0.909	0.281	-0.567	6.661
	Prob.	***0.772***	***0.973***	***0.864***	***0.999***
		n0	n0	n0	n0
With Constant & Trend	t-Statistic	-1.957	-1.927	-1.694	1.609
	Prob.	***0.6015***	***0.616***	***0.730***	***0.999***
		n0	n0	n0	n0
Without Constant & Trend	t-Statistic	0.2449	3.315	0.643	7.986
	Prob.	***0.750***	***0.999***	***0.849***	***0.999***
		n0	n0	n0	n0

		At First Difference			
		d(GDPP)	d(FIXTEL)	d(MOBSUB)	d(NETUSER)
With Constant	t-Statistic	-5.086	-5.648	-3.398	-1.921
	Prob.	***0.000*** ***	***5.413*** ***	***0.0187*** **	***0.318*** n0
With Constant & Trend	t-Statistic	-5.004	-5.620	-3.336	-4.761
	Prob.	***0.001*** ***	***0.000*** ***	***0.0491*** **	***0.003*** ***
Without Constant & Trend	t-Statistic	-5.029	-4.4510	-2.8017	-0.886
	Prob.	***1.011*** ***	***6.255*** ***	***0.006*** ***	***0.323*** n0

UNIT ROOT TEST TABLE (ADF)

		At Level			
		GDPP	FIXTEL	MOBSUB	NETUSER
With Constant	t-Statistic	-0.879	0.1406	-1.171	6.661
	Prob.	***0.781*** n0	***0.963*** n0	***0.673*** n0	***0.999*** n0
With Constant & Trend	t-Statistic	-1.7549	-1.872	-2.803	5.154
	Prob.	***0.702*** n0	***0.644*** n0	***0.206*** n0	***0.999*** n0
Without Constant & Trend	t-Statistic	0.2627	2.9742	-0.1689	9.346
	Prob.	***0.755*** n0	***0.998*** n0	***0.616*** n0	***0.999*** n0

		At First Difference			
		d(GDPP)	d(FIXTEL)	d(MOBSUB)	d(NETUSER)
With Constant	t-Statistic	-5.084	-5.643	-2.456	2.814
	Prob.	***0.000*** ***	***0.005*** ***	***0.136*** n0	***0.999*** n0
With Constant & Trend	t-Statistic	-5.002	-5.614	-2.402	-4.732
	Prob.	***0.0017*** ***	***0.000*** ***	***0.043*** **	***0.003*** ***
Without Constant & Trend	t-Statistic	-5.041	-4.397	-1.609	3.506
	Prob.	***0.009*** ***	***0.007*** ***	***0.100*** n0	***0.999*** n0

Notes: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant
*MacKinnon (1996) one-sided p-values.

Annexe2 :

Dependent Variable: LOG(GDPP)
Method: ARDL
Date: 07/05/24 Time: 21:35
Sample: 1995 2021
Included observations: 27
Dependent lags: 2 (Automatic)

Automatic-lag linear regressors (5 max. lags): MOBSUB NETUSER FIXTEL
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 432
Selected model: ARDL(1,5,5,4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(GDPP(-1))	0.89672	0.4007	2.237	0.05560
MOBSUB	0.01144	0.0034	3.273	0.01130
MOBSUB(-1)	-0.01611	0.0067	-2.3905	0.04381
MOBSUB(-2)	-0.0053	0.0058	-0.9147	0.38707
MOBSUB(-3)	0.0349	0.0096	3.633	0.00665
MOBSUB(-4)	-0.0445	0.0115	-3.8446	0.00491
MOBSUB(-5)	0.0323	0.0077	4.1883	0.003044
NETUSER	-0.10404	0.0282	-3.67986	0.006220
NETUSER(-1)	0.10325	0.0342	3.0111	0.016783
NETUSER(-2)	0.033	0.0158	2.13161	0.065
NETUSER(-3)	-0.1869	0.0446	-4.18934	0.00304
NETUSER(-4)	0.2752	0.0678	4.05780	0.00364
NETUSER(-5)	-0.1614	0.0408	-3.95168	0.00422
FIXTEL	0.19292	0.0617	3.12197	0.0141
FIXTEL(-1)	-0.0225	0.0890	-0.25347	0.80629
FIXTEL(-2)	-0.2566	0.0791	-3.2443	0.01180
FIXTEL(-3)	0.5445	0.1375	3.9578	0.00418
FIXTEL(-4)	-0.407	0.1091	-3.7386	0.00571
C	0.4197	2.8115	0.1492	0.8850

R-squared	0.995	Mean dependent var	8.033341
Adjusted R-squared	0.986	S.D. dependent var	0.464618
S.E. of regression	0.0549	Akaike info criterion	-2.77291
Sum squared resid	0.0241	Schwarz criterion	-1.861032
Log likelihood	56.4343	Hannan-Quinn criter.	-2.501766
F-statistic	102.7334	Durbin-Watson stat	2.12043
Prob(F-statistic)	1.657		

*Note: p-values and any subsequent test results do not account for model selection.

Annexe3 :

Null hypothesis: No levels relationship
Number of cointegrating variables: 3
Trend type: Unrest. constant (Case 3)
Sample size: 27

Test Statistic	Value

F-statistic	9.906
t-statistic	-0.257

bonds critical values

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
			F-Statistic			
30	3.008	4.150	3.71	5.018	5.333	7.063
Asymptotic	2.72	3.77	3.23	4.35	4.29	5.610
			t-Statistic			
Asymptotic	-2.57	-3.46	-2.86	-3.78	-3.43	-4.37

* I(0) and I(1) are respectively the stationary and non-stationary bounds.

Annexe4 :

Deterministics: Unrest. constant (Case 3)

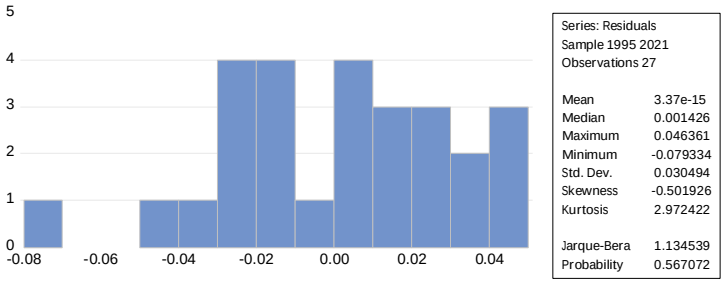
CE = LOG(GDPP(-1)) - (0.122094*MOBSUB(-1) - 0.388140*NETUSER(
-1) + 0.488127*FIXTEL(-1))

Cointegration coefficients

Variable *	Coefficient	Std. Error	t-Statistic	Prob.
MOBSUB(-1)	0.12204	0.447	0.272	0.787
NETUSER(-1)	-0.3883	1.485	-0.261	0.796
FIXTEL(-1)	0.4886	1.596	0.305	0.762

Note:* Coefficients derived from the CEC regression.

Annexe5 :



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